

## PHYC 330 Mechanics

### Course Description

Basic concepts of mechanics, general motion of particles in three dimensions. Simple and damped harmonic motion. Particle dynamics in noninertial frames of reference, central forces. Dynamics of systems of particles. Motion of rigid bodies in three dimensions. Dynamics of oscillation systems. (3 credit hours)

Prerequisite: PHYC 120 and MATH 162.

### Course Objectives

A course in classical mechanics at the intermediate level, drawing heavily on the calculus and giving strong emphasis to solutions of problems. This is the second course in mechanics in the standard sequence taken by physics majors and minors (the first being PHYC 120). Extensive practice is offered in setting up differential equations for specific problems and carrying out the integrations.

### Course Rationale

This introductory mechanics course is the first analytical physics course for the physics majors and minors. This will provide an opportunity for developing problem solving skills and application of calculus. The problem solving skills and critical thinking developed in this course are necessary for success in the advanced level physics course.

### Course Content, Format, and Bibliography

#### *Content*

#### Kinematics

- Speed, velocity, and acceleration
- Transformation of moving axes
- Treatment of vectors
- Circular motion

#### Force and Motion of Particle

- Newton's Laws of Motion: Force and mass
- Position dependent forces, concepts of kinetic and potential energies
- Conservation of energy
- Velocity-dependent forces, vertical fall through a fluid, terminal velocity

#### Harmonic Oscillations

- Mass on a spring
- Pendulum

- Energy considerations in harmonic motion
- Damped harmonic motion
- General Motion of Particle in Three Dimensions
  - Potential energy function in three dimensional motion
  - Projectile motion
  - Harmonic oscillator in two and three dimensions
  - Motion of charged particles in electric and magnetic fields
  - Constrained motion of a particle
- Noninertial Reference Systems
  - Accelerated coordinate systems and inertial forces
  - Rotating coordinate systems
  - Dynamics of a particle in a rotation coordinate system
  - Effect of Earth's rotation
  - Motion of a projectile in a rotating cylinder
  - The Foucault pendulum
- Gravitation and Central Forces
  - Gravitational force between a uniform sphere and a particle
  - Kepler's laws
  - Potential energy in a gravitational field
- Dynamics of Systems of Particles
  - Center of mass and linear momentum of a system
  - Angular momentum and kinetic energy of a system
  - Collisions
  - Comparison of laboratory and center of mass coordinates
  - Rocket motion
- Mechanics of Rigid Bodies
  - Center of mass of a rigid body
  - Moment of inertia
  - Physical pendulum
  - General theorem concerning angular momentum
  - Impulse and collisions involving rigid bodies
- Dynamics of Oscillating Systems
  - Potential energy and equilibrium
  - Stable equilibrium

Coupled harmonic oscillator

General theory of vibrating systems

Lagrange's Equations and Hamiltonian Function

Generalized coordinates

Application of Lagrange's Equations

Hamilton's Variation Principle

Hamilton's Equations

*Format*

Homework assignments, quizzes, and examinations.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

*Bibliography*

Fowles, Analytical Mechanics, 7<sup>th</sup> Ed., Thomson, ISBN 0534494927

Introduction to Classical Mechanics by A.P. Ary